**APES REVIEW – INTRODUCTION TO ENVIRONMENTAL SCIENCE**

**Key Questions & Learning Targets**

**Chapter 1 – Environmental Problems, Their Causes, and Sustainability**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 6. What is **exponential growth?** Why is living inan exponential age a cause for concern for everyone livingon the planet?**2.** Define **environment.** Distinguish among **environmental****science, ecology,** and **environmentalism.** Distinguishbetween an **organism** and a **species.** What is an**ecosystem?** What is **sustainability?** Explain the terms**natural capital, natural resources, natural services,****solar capital,** and **natural capital degradation.** Whatis **nutrient cycling** and why is it important? Describe theultimate goal of an **environmentally sustainable society.**What is **natural income?****3.** What is the difference between **economic growth** and**economic development?** Distinguish among **gross****domestic product (GDP), per capita GDP,** and **per****capita GDP PPP.** Distinguish between **developed****countries** and **developing countries** and describe theirkey characteristics. What is **environmentally sustainable****economic development?****4.** What is a **resource?** What is **conservation?** Distinguishamong a **renewable resource, nonrenewable resource,**and **perpetual resource** and give an example ofeach. What is **sustainable yield?** Define and give threeexamples of **environmental degradation.** What is thetragedy of the commons? Distinguish between **recycling**and **reuse** and give an example of each. What is an **ecological footprint?** What is a **per capita ecological****footprint?** Compare the total and per capita ecologicalfootprints of the United States and China. | **5.** What is **culture?** Describe three major cultural changesthat have occurred since humans arrived on the earth.Why has each change led to more environmental degradation? What is the **environmental** or **sustainability revolution?****6.** Define **pollution.** Distinguish between **point sources**and **nonpoint sources** of pollution. Distinguish between**biodegradable pollutants** and **nondegradable pollutants**and give an example of each. Distinguish between**pollution cleanup** and **pollution prevention** and givean example of each. Describe three problems with solutions that rely mostly on pollution cleanup.**7.** Identify five basic causes of the environmental problemsthat we face today. What is **poverty?** In what ways dopoverty and affluence affect the environment? Explainthe problems we face by not including the harmful environmental costs in the prices of goods and services.**8.** What is an **environmental worldview?** What is **environmental ethics?** Distinguish among the **planetary****management, stewardship,** and **environmental wisdom****worldviews.** Describe Aldo Leopold’s environmentalethics. What major steps are involved in making anenvironmental decision? What is **social capital?****9.** Discuss the lessons we can learn from the environmental transformation of Chattanooga, Tennessee (USA). Explain why individuals matter in dealing with the environmental problems we face.**10.** What are four **scientific principles of sustainability**?Explain how exponential growth (**Core Case Study**) affects them. |

**Chapter 2 – Science, Matter, Energy, and Systems**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 29. Describe the controlled scientific experimentcarried out at the Hubbard Brook ExperimentalForest. What is **science?** Describe the steps involved inthe scientific process. What is **data?** What is an **experiment?** What is a **model?** Distinguish among a **scientific hypothesis, scientific theory,** and **scientific law** (**law of nature**). What is **peer review** and why is itimportant? Explain why scientific theories are not to betaken lightly and why people often use the term “theory”incorrectly. | **2.** Distinguish between **inductive reasoning** and **deductive****reasoning** and give an example of each. Explainwhy scientific theories and laws are the most importantresults of science.**3.** What is a **paradigm shift?** Distinguish among **tentative****science** (**frontier science**), **reliable science,** and**unreliable science.** Describe the scientific consensusconcerning global warming. What is **statistics?** What is**probability** and what is its role in scientific conclusions?What are five limitations of science and environmentalscience? |

**Chapter 2 (continued)**

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| **4.** What is **matter?** Distinguish between an **element**and a **compound** and give an example of each. Distinguishamong **atoms, ions,** and **molecules** and give an example of each. What is the **atomic theory?** Distinguishamong **protons, neutrons,** and **electrons.** What isthe **nucleus** of an atom? Distinguish between the **atomic****number** and the **mass number** of an element. What isan **isotope?** What is **acidity?** What is **pH?****5.** What is a **chemical formula?** Distinguish between**organic compounds** and **inorganic compounds** andgive an example of each. Distinguish among complexcarbohydrates, proteins, nucleic acids, and lipids. Whatis a **cell?** Distinguish among **genes, traits,** and **chromosomes.** What is **matter quality?** Distinguish between **high-quality matter** and **low-quality matter** and givean example of each.**6.** Distinguish between a **physical change** and a **chemical****change (chemical reaction)** and give an exampleof each. What is a **nuclear change?** Explain the differencesamong **natural radioactive decay, nuclear****fission,** and **nuclear fusion.** What is a **radioactive****isotope (radioisotope)?** What is a **chain reaction?**What is the **law of conservation of matter** and why isit important?**7.** What is **energy?** Distinguish between **kinetic energy**and **potential energy** and give an example of each.What is **heat?** Define and give two examples of **electromagnetic radiation.** What is **energy quality?** Distinguishbetween **high-quality energy** and **low-quality****energy** and give an example of each. | **8.** What is the **law of conservation of energy (first law****of thermodynamics)** and why is it important? Whatis the **second law of thermodynamics** and why isit important? Explain why this law means that we cannever recycle or reuse high-quality energy. What is**energy efficiency (energy productivity)** and why is itimportant?**9.** Define and give an example of a **system?** Distinguishamong the **input, flow (throughput),** and **output** of asystem. Why are scientific models useful? What is **feedback?** What is a **feedback loop?** Distinguish betweena **positive feedback loop** and a **negative (corrective)****feedback loop** in a system, and give an example of each.Distinguish between a **time delay** and a **synergistic interaction (synergy)** in a system and give an example ofeach. What is a **tipping point?****10.** Explain how human activities can have unintendedharmful environmental results. Relate the four**scientific principles of sustainability** to the HubbardBrook Experimental Forest controlled experiment(**Core Case Study**). |

**APES REVIEW – EARTH’S SYSTEMS**

**Key Questions & Learning Targets**

**Chapter 7 – Climate and Terrestrial Biodiversity**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 141. Describe the environmentally beneficial andharmful effects of the earth’s winds.**2.** Distinguish between **weather** and **climate.** Describethree major factors that determine how air circulates inthe lower atmosphere. Describe how the properties of air,water, and land affect global air circulation. How is heatdistributed to different parts of the ocean? Explain howglobal air circulation and ocean currents lead to the forests, grasslands, and deserts that make up the earth’s terrestrial biomes.**3.** Define and give four examples of a **greenhouse gas.**What is the **greenhouse effect** and why is it importantto the earth’s life and climate? What is the **rain shadow****effect** and how can it lead to the formation of inlanddeserts? Why do cities tend to have more haze and smog,higher temperatures, and lower wind speeds than the surrounding countryside?**4.** What is a **biome?** Explain why there are three majortypes of each of the major biomes (deserts, grasslands, and forests). Describe how climate and vegetation vary with latitude and elevation.**5.** Describe how the three major types of deserts differ intheir climate and vegetation. How do desert plants andanimals survive? | **6.** Describe how the three major types of grasslands differin their climate and vegetation. What is a savanna? Whyhave many of the world’s temperate grasslands disappeared? What is **permafrost?** Distinguish between arctic tundra and alpine tundra.**7.** What is temperate shrubland or chaparral? Why is this biome a desirable place to live? Why is it a risky place to live?**8.** What is a **forest system** and what are the three majortypes of forests? Describe how these three types differin their climate and vegetation. Why is biodiversityso high in tropical rain forests? Why do most soils intropical rain forests have few plant nutrients? Describewhat happens in temperate deciduous forests in thewinter and fall. What are coastal coniferous or temperaterain forests? What important ecological roles do mountains play?**9.** Describe how human activities have affected the world’sdeserts, grasslands, forests, and mountains.**10.** Describe the connections between the earth’swinds, climates, and biomes (**Core Case Study**) and the four **scientific principles of sustainability** (see back cover). |

**Chapter 8 – Aquatic Biodiversity**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 163. What is a **coral reef** and why shouldwe care about coral reefs? What is coral bleaching?**2.** What percentage of the earth’s surface is covered withwater? What is an **aquatic life zone?** Distinguish betweena **saltwater (marine)** life zone and a **freshwater**life zone. What major types of organisms live in the top,middle, and bottom layers of aquatic life zones? Define**plankton** and describe three types of plankton. Distinguishamong **nekton, benthos,** and **decomposers** and give an example of each. What five factors determine thetypes and numbers of organisms found in the three layersof aquatic life zones? What is **turbidity,** and how does itoccur? Describe one of its harmful impacts. | **3.** What major ecological and economic services are provided by marine systems? What are the three major lifezones in an ocean? Distinguish between the **coastal****zone** and the **open sea.** Distinguish between an**estuary** and a **coastal wetland** and explain why theyhave high net primary productivities. What is a **mangrove****forest** and what is its ecological and economicimportance? What is the **intertidal zone?** Distinguishbetween rocky and sandy shores. Why does the open seahave a low net primary productivity?**4.** What human activities pose major threats to marine systems and to coral reefs?**5.** Explain why the Chesapeake Bay is an estuary in trouble.What is being done about some of its problems? |

**Chapter 8 (continued)**

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| **6.** What major ecological and economic services do freshwater systems provide? What is a **lake?** What fourzones are found in most lakes? Distinguish among**oligotrophic, eutrophic, hypereutrophic,** and **mesotrophic****lakes.** What is **cultural eutrophication?****7.** Define **surface water, runoff,** and **watershed (drainage****basin).** Describe the three zones that a stream passesthrough as it flows from mountains to the sea. Describethe relationships between dams, deltas, wetlands, hurricanes, and flooding in New Orleans, Louisiana (USA).**8.** Give three examples of **inland wetlands** and explain theecological importance of such wetlands. | **9.** What are four ways in which human activities are disrupting and degrading freshwater systems? Describe inland wetlands in the United States in terms of the area ofwetlands lost and the resulting loss of ecological and economic services.**10.** How is the degradation of many of the earth’scoral reefs (**Core Case Study**) a reflection ofour failure to follow the four **scientific principles****of sustainability**? Describe this connectionfor each principle. |

**Chapter 14 - Geology**

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| **1.** Review the Key Questions and Concepts for this chapter on p. 345. Describe the environmental effects of gold mining.**2.** Define **geology, core, mantle, crust, tectonic plate,**and **lithosphere.** What is a transform fault? What is**weathering** and why is it important? Define **volcano**and describe the nature and effects of a volcanic eruption.Define and describe the nature and effects of an **earthquake.** What is a **tsunami** and what are its effects? | **3.** Define **mineral, rock, sedimentary rock, igneous****rock,** and **metamorphic rock** and give an example ofeach. Describe the nature and importance of the **rock****cycle.** |

**APES REVIEW – ECOLOGY, ECOSYSTEMS AND POPULATION STUDIES**

**Key Questions & Learning Targets**

**Chapter 3 – Ecosystems: What Are They and How Do They Work?**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 51. What are three harmful effects resulting fromthe clearing and degradation of tropical rain forests?**2.** What is a **cell?** What is the **cell theory?** Distinguishbetween a **eukaryotic cell** and a **prokaryotic cell.**What is a **species?** Explain the importance of insects.Define **ecology.** What is **genetic diversity?** Distinguishamong a **species, population, community (biological****community), habitat, ecosystem,** and the **biosphere.****3.** Distinguish among the **atmosphere, troposphere,****stratosphere, greenhouse gases, hydrosphere,** and **geosphere.** Distinguish between **biomes** and **aquatic****life zones** and give an example of each. What three interconnected factors sustain life on earth?**4.** Describe what happens to solar energy as it flows to andfrom the earth. What is the **natural greenhouse effect**and why is it important for life on earth?**5.** Distinguish between the **abiotic** and **biotic components**in ecosystems and give two examples of each. What is the**range of tolerance** for an abiotic factor? Define and givean example of a **limiting factor.** What is the **limiting****factor principle?****6.** What is a **trophic level?** Distinguish among **producers****(autotrophs), consumers (heterotrophs),** and **decomposers** and give an example of each in an ecosystem.Distinguish among **primary consumers (herbivores), secondary consumers (carnivores), high-level (third level) consumers, omnivores, decomposers,** and **detritus feeders (detritivores),** and give an exampleof each. | **7.** Distinguish among **photosynthesis, chemosynthesis,****aerobic respiration,** and **anaerobic respiration (fermentation).** What two processes sustain ecosystems andthe biosphere and how are they linked? Explain the importanceof microbes.**8.** Explain what happens to energy as it flows through thefood chains and food webs of an ecosystem. Distinguishbetween a **food chain** and a **food web.** What is **biomass?**What is **ecological efficiency?** What is the **pyramid****of energy flow?** Discuss the difference between**gross primary productivity (GPP)** and **net primary****productivity (NPP)** and explain their importance.**9.** What happens to matter in an ecosystem? What is a**biogeochemical cycle (nutrient cycle)?** Describe theunique properties of water. What is **transpiration?** Describe the **hydrologic (water), carbon, nitrogen, phosphorus,** and **sulfur cycles** and describe how humanactivities are affecting each cycle.**10.** Describe three ways in which scientists study ecosystems. Explain why we need much more basic dataabout the structure and condition of the world’s ecosystems. How are the four **scientific principles****of sustainability** showcased in tropicalrain forests (**Core Case Study**)? |

**Chapter 4 – Biodiversity and Evolution**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 78. Explain why we should protect the Americanalligator (**Core Case Study**) from being driven toextinction as a result of our activities.**2.** What are the four major components of **biodiversity****(biological diversity)?** What is the importance ofbiodiversity? | **3.** What is **biological evolution?** What is **natural selection?**What is a **fossil** and why are fossils important inunderstanding biological evolution? What is a **mutation**and what role do mutations play in evolution by naturalselection? What is an **adaptation (adaptive trait)?**What is **differential reproduction?** How did we becomesuch a powerful species? |

**Chapter 4 (continued)**

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| **4.** What are two limits to evolution by natural selection?What are three myths about evolution through naturalselection?**5.** Describe how geologic processes and climate changecan affect natural selection. Describe conditions onthe earth that favor the development of life as weknow it.**6.** What is **speciation?** Distinguish between **geographic****isolation** and **reproductive isolation** and explainhow they can lead to the formation of a new species.Distinguish between **artificial selection** and **genetic****engineering (gene splicing)** and give an example ofeach. What are some possible social, ethical, and environmental problems with the widespread use of genetic engineering? What is **extinction?** What is an **endemic** **species** and why is it vulnerable to extinction? Distinguish between **background extinction** and **mass****extinction.** | **7.** What is **species diversity?** Distinguish between**species richness** and **species evenness** and give anexample of each. Describe the **theory of island biogeography (species equilibrium model).** Explainwhy species-rich ecosystems tend to be productive andsustainable.**8.** What is an **ecological niche?** Distinguish between **specialist species** and **generalist species** and give an exampleof each.**9.** Distinguish among **native, nonnative, indicator,****keystone,** and **foundation** species and give an exampleof each type. Explain why birds are excellent indicatorspecies. Why are amphibians vanishing and why shouldwe protect them? Why should we protect shark speciesfrom being driven to extinction as a result of our activities?Describe the role of the beaver as a foundationspecies.**10.** Explain how the role of the American alligatorin its ecosystem (**Core Case Study**) illustratesthe biodiversity **principles of sustainability**? |

**Chapter 5 – Biodiversity, Species Interactions, and Population Control**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 101. Explain how southern sea otters act as a keystone species in kelp beds. Explain why we should careabout protecting this species from extinction. Explain whywe should help to preserve kelp forests.**2.** Define **interspecific competition, predation, parasitism,****mutualism,** and **commensalism** and give an exampleof each. Explain how each of these species interactionscan affect the population sizes of species in ecosystems.Distinguish between a **predator** and a **prey** and give anexample of each. What is a **predator–prey relationship?**Describe four ways in which prey species can avoidtheir predators and four ways in which predators can capture these prey.**3.** Define and give an example of **coevolution.****4.** Describe and give an example of **resource partitioning**and explain how it can increase species diversity.**5.** What is **population dynamics?** Why do most populations live in clumps? | **6.** Describe four variables that govern changes in population size and write an equation showing how they interact. What is a population’s **age structure** and whatare three major age group categories? Distinguish amongthe **biotic potential, intrinsic rate of increase, exponential****growth, environmental resistance, carrying capacity,** and **logistic growth** of a population, and usethese concepts to explain why there are always limits to population growth in nature. Why are southern sea ottersmaking a slow comeback and what factors can threatenthis recovery? Define and give an example of a **population crash.** Explain why humans are not exempt fromnature’s population controls.**7.** Distinguish between **r-selected species** and **K-selected****species** and give an example of each type. Define **population density** and explain how it can affect the size ofsome but not all populations.**8.** Describe the exploding white-tailed deer population problem in the United States and discuss options for dealing with it. |

**Chapter 5 (continued)**

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| **9.** What is **ecological succession?** Distinguish between**primary ecological succession** and **secondary ecological****succession** and give an example of each. Explainwhy succession does not follow a predictable path. Interms of stability, distinguish between **inertia (persistence)** and **resilience.** Explain how living systemsachieve some degree of stability or sustainability by undergoing constant change in response to changing environmental conditions. | **10.** Explain how the role of the southern seaotter in its ecosystem (**Core Case Study**) illustrates the population control **principle** **of sustainability**. |

**Chapter 6 – The Human Population and Its Impact**

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| **1.** Review the Key Questions and Concepts in this chapteron p. 123. Do you think the world is overpopulated?Explain.**2.** List three factors that account for the rapid growth of the world’s human population over the past 200 years. Describe eight ways in which we have used technology toalter nature to meet our growing needs and wants. Howmany of us are likely to be here in 2050?**3.** What is the **cultural carrying capacity** of a population?How do some analysts apply this concept in consideringthe question of whether the earth is overpopulated?**4.** List four variables that affect the **population change** ofan area and write an equation showing how they are related. Distinguish between **crude birth rate** and **crude****death rate.** What five countries had the largest numbersof people in 2008? **5.** What is **fertility rate?** Distinguish between **replacement-level fertility rate** and **total fertility****rate (TFR).** Explain why reaching the replacement-levelfertility rate will not stop global population growth untilabout 50 years have passed (assuming that death rates donot rise).**6.** Describe population growth in the United States andexplain why it is high compared to those of most otherdeveloped countries and China. Is the United States overpopulated? Explain. | **7.** List ten factors that can affect the birth rate and fertilityrate of a country. Distinguish between **life expectancy**and **infant mortality rate** and explain how they affectthe population size of a country. Why does the UnitedStates have a lower life expectancy and higher infantmortality rate than a number of other countries? What is**migration?** Describe immigration into the United Statesand the issues it raises.**8.** What is the **age structure** of a population. Explain howit affects population growth and economic growth. Whatare some problems related to rapid population declinefrom an aging population?**9.** What is the **demographic transition** and what are itsfour stages? What factors could hinder some developingcountries from making this transition? What is **family****planning?** Describe the roles of family planning, reducingpoverty, and elevating the status of women in slowingpopulation growth. Describe China’s and India’s efforts tocontrol their population growth.**10.** How has human population growth (**Core Case****Study**) interfered with natural processes relatedto three of the **scientific principles of sustainability**?Name the three principles, and for each one,describe the effects of rapid human population growth. |

**Chapter 9 – Sustaining Biodiversity: The Species Approach**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 184. What factors led to the premature extinction ofthe passenger pigeon in the United States? | **2.** Distinguish between **background extinction** and**mass extinction.** What is the **extinction rate** of a species? Describe how scientists estimate extinction rates. Give four reasons why many extinction experts believe that human activities are now causing a sixth mass extinction. Distinguish between **endangered** **species** and **threatened species.** List some characteristics that make some species especially vulnerable to extinction. |

**Chapter 9 (continued)**

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| **3.** What are two reasons for trying to prevent the premature extinction of wild species? What is the **instrumental** **value** of a species? List six types of instrumental values provided by wild species. How are scientists using DNA analysis to reduce the illegal killing of elephants? What is the **intrinsic (existence) value** of a species?**4.** What is biophilia? Why should we care about bats?**5.** What is **HIPPCO?** In order, what are the six largestcauses of premature extinction of species resulting fromhuman activities? Why are island species especially vulnerable to extinction? What is habitat fragmentation, and how does it threaten many species?**6.** Describe the threats to bird species in the world and inthe United States. List three reasons why we should bealarmed by the decline of bird species.**7.** Give two examples of the harmful effects of nonnativespecies that have been introduced **(a)** deliberately and**(b)** accidentally. List ways to limit the harmful impactsof nonnative species. Describe the roles of populationgrowth, overconsumption, pollution, and climate changein the premature extinction of wild species. Describe whatis happening to many of the honeybees in the UnitedStates and what economic and ecological roles they play.Explain how pesticides such as DDT can be biomagnifiedin food chains and webs. Explain how global warming isthreatening polar bears. | **8.** Describe the poaching of wild species and give threeexamples of species that are threatened by this illegalactivity. Describe the work of Jane Goodall in protectingwild primates. Why are tigers likely to disappear from thewild by the end of this century? Describe the threat tosome forms of wildlife from increased hunting for bushmeat.**9.** Describe two international treaties that are used to helpprotect species. Describe the U.S. Endangered SpeciesAct, how successful it has been, and the controversy overthis act. Describe the roles of wildlife refuges, gene banks,botanical gardens, wildlife farms, zoos, and aquariums inprotecting some species.**10.** Describe how protecting wild species frompremature extinction (**Core Case Study**) is inkeeping with the four **scientific principles of****sustainability**. |

**APES REVIEW – Global Resources**

**Key Questions & Learning Targets**

**Chapter 10 – Sustaining Terrestrial Biodiversity: The Ecosystem Approach**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 215. Describe the beneficial effects of reintroducingthe keystone gray wolf species (Figure 10-1)into Yellowstone National Park in the United States(**Core Case Study**).**2.** Distinguish among an **old-growth forest,** a**second-growth forest,** and a **tree plantation (tree****farm or commercial forest).** What major ecological andeconomic benefits do forests provide? Describe the effortsof scientists and economists to put a price tag on themajor ecological services provided by forests and otherecosystems.**3.** What harm is caused by building roads into previously inaccessible forests? Distinguish among *selective cutting, clearcutting,* and *strip cutting* in the harvesting of trees. What are the major advantages and disadvantages of clear-cutting forests?**4.** What are two types of forest fires? What are some ecological benefits of occasional surface fires? What arefour ways to reduce the harmful impacts of diseases andinsects on forests? What effects might projected globalwarming have on forests?**5.** What parts of the world are experiencing the greatestforest losses? Define **deforestation** and list some of itsmajor harmful environmental effects. Describe the encouraging news about deforestation in the United States. What are the major basic and secondary causes of tropical deforestation?**6.** Describe four ways to manage forests more sustainably.What is certified timber? What are four ways to reducethe harms to forests and to people from forest fires? Whatare three ways to reduce the need to harvest trees? Whatis the fuelwood crisis and what are three ways to reduceits severity? Describe the Green Belt Movement. What arefive ways to protect tropical forests and use them moresustainably? | **7.** Distinguish between **rangelands** and **pastures.** Distinguish between the **overgrazing** and **undergrazing** ofrangelands. What are three ways to reduce overgrazingand use rangelands more sustainably? Describe the conflict between ranching and urban development in theAmerican West.**8.** What major environmental threats affect national parks? How could national parks in the United States be used more sustainably? Describe some of the ecological effects of reintroducing the gray wolf to Yellowstone National Park in the United States (**Core Case Study**). Whatpercentage of the world’s land has been set asideand protected as nature reserves, and what percentage doconservation biologists believe should be protected?**9.** How should nature reserves be designed and connected? Describe what Costa Rica has done to establish nature reserves. What is **wilderness** and why is it important? Describe the controversy over protecting wilderness in the United States. What is a **biological hotspot** and why is it important to protect such areas? Why is it also important to protect areas where deteriorating ecosystem services threaten people and other forms of life?**10.** What is **ecological restoration?** What are the fourparts of a prominent strategy for carrying out ecologicalrestoration and rehabilitation? Describe the ecologicalrestoration of a tropical dry forest in Costa Rica. Defineand give three examples of **reconciliation (applied)****ecology.** Describe the relationship between reestablishingwolves in Yellowstone National park (**Core Case Study**) and the four **scientific** **principles of sustainability**. |

**Chapter 11 – Sustaining Aquatic Biodiversity**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 250. Describe how human activities have upset ecological processes in East Africa’s Lake Victoria(**Core Case Study**).**2.** What are three general patterns of marine biodiversity?Why is marine biodiversity higher **(a)** near coaststhan in the open sea and **(b)** on the ocean’s bottom thanat its surface? Describe the threat to marine biodiversityfrom bottom trawling. Give two examples of threats toaquatic systems from invasive species. Describe the ecological experiment involving carp removal in Wisconsin’s Lake Wingra. How does climate change threaten aquatic biodiversity?**3.** What is a **fishprint?** Describe the collapse of the cod fishery in the northwest Atlantic and some of its side effects. Describe the effects of trawler fishing, purse-seine fishing, longlining, and drift-net fishing.**4.** How have laws and treaties been used to help sustainaquatic species? Describe international efforts to protect whales from overfishing and premature extinction. Describe threats to sea turtles and efforts to protect them.**5.** Describe the use of marine protected areas and marinereserves to help sustain aquatic biodiversity and ecosystem services. What percentage of the world’s oceans is fully protected from harmful human activities in marine reserves? Describe the roles of fishing communitiesand individual consumers in regulating fishing and coastaldevelopment. What is integrated coastal management? | **6.** Describe and discuss the limitations of three ways to estimate the sizes of fish populations. How can the precautionary principle help in managing fisheries and large marine systems? Describe the efforts of local fishing communities in helping to sustain fisheries. How can government subsidies encourage overfishing? Describe the advantages and disadvantages of using individual transfer rights to help manage fisheries.**7.** Describe how consumers can help to sustain fisheries,aquatic biodiversity, and ecosystem services by makingcareful choices in purchasing seafood.**8.** What percentage of the U.S. coastal and inland wetlandshas been destroyed since 1900? What are three majorecological services provided by wetlands? How does theUnited States attempt to reduce wetland losses? Describeefforts to restore the Florida Everglades.**9.** Describe the major threats to the world’s rivers and other freshwater systems. What major ecological services do rivers provide? Describe invasions of the U.S. Great Lakes by nonnative species. Describe ways to help sustain rivers.**10.** What are six priorities for protecting terrestrial andaquatic biodiversity? Relate the ecological problemsof Lake Victoria (**Core Case Study**) to the four **scientific principles of sustainability**. |

**Chapter 12 – Food, Soil, and Pest Management**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 276. Describe the use of genetically engineeredgolden rice (**Core Case Study**) as a way to decreasevitamin A deficiency in children.**2.** Define **food security** and **food insecurity.** What isthe root cause of food insecurity? Distinguish between**chronic undernutrition (hunger)** and **chronic malnutrition**and describe their harmful effects. Describe theeffects of diet deficiencies in vitamin A, iron, and iodine.What is a **famine?** What is **overnutrition,** and what areits harmful effects? | **3.** What three systems supply most of the world’s food? Distinguish among **industrialized agriculture (high-input****agriculture), plantation agriculture, traditional subsistence agriculture, traditional intensive agriculture,****polyculture,** and **slash-and-burn agriculture.** Define **soil** and describe its formation and the major layersin mature soils. What is a **green revolution?** Describeindustrialized food production in the United States.**4.** Distinguish between *crossbreeding* and *genetic engineering.* Describe industrialized meat production. What is a **fishery?**What is **aquaculture?** |

**Chapter 12 (continued)**

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| **5.** What are the major harmful environmental impacts ofagriculture? What is **soil erosion** and what are its twomajor harmful environmental effects? What is **desertification** and what are its harmful environmental effects?Distinguish between **salinization** and **waterlogging** ofsoil and describe their harmful environmental effects.**6.** What factors can limit green revolutions? Describe theuse of energy in industrialized agriculture. Describe theadvantages and disadvantages of genetically engineeredfoods. Explain how most food production systems reducebiodiversity. Describe the advantages and disadvantages ofindustrialized meat production. Describe the advantagesand disadvantages of aquaculture.**7.** What is a **pest?** Define and give two examples of a **pesticide.** Describe Rachel Carson’s contribution to environmentalscience. Describe the advantages and disadvantagesof modern pesticides. Describe the dilemma overwidespread use of glyphosate as an herbicide. Describethe use of laws and treaties to help protect us from theharmful effects of pesticides. Describe seven alternativesto conventional pesticides. Define **integrated pest management (IPM)** and discuss its advantages. | **8.** Describe three ways in which governments influence food production. What is **soil conservation?** Describe seven ways to reduce soil erosion. Describe soil erosion and soil conservation in the United States. Distinguish among the use of **organic fertilizer, commercial inorganic fertilizer,** **animal manure, green manure,** and **compost** asways to help restore soil fertility. Describe ways to preventand clean up soil salinization.**9.** Describe ways to produce meat more efficiently, humanely, and sustainably. How can we make aquaculturemore sustainable? Define **organic agriculture** anddescribe its advantages over conventional agriculture.Describe the advantages of relying more on polyculturesof perennial crops. What can individuals do to promotemore sustainable agriculture?**10.** Describe the relationships among golden rice(**Core Case Study**), sustainable agriculture,and the four **scientific principles of sustainability**. |

**Chapter 13 – Water Resources**

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| **1.** Review the Key Questions and Concepts for this Chapteron p. 314. Describe water conflicts in the Middle East andpossible solutions to these problems.**2.** What percentage of the earth’s freshwater is availableto us? Define **groundwater, zone of saturation, water table,** and **aquifer.** Define **surface water, surface runoff,** and **watershed (drainage basin).** Distinguishbetween surface runoff and **reliable surface runoff.** What percentage of the world’s reliable runoff arewe using and what percentage are we likely to be usingby 2025?**3.** How is most of the world’s water used? Describe theavailability and use of freshwater resources in theUnited States. How many people in the world lackregular access to safe drinking water, and how many donot have access to basic sanitation? What is **drought**and what are its causes and harmful effects? Discuss thequestion of who should own and manage freshwaterresources.**4.** What are the advantages and disadvantages of withdrawing groundwater? Describe the problem of groundwater depletion in the world and in the United States, especially over the Ogallala aquifer. Describe ways to prevent or slow groundwater depletion. | **5.** What is a **dam?** What is a **reservoir?** What are the advantages and disadvantages of large dams and reservoirs? What ecological services do rivers provide? Describe some problems associated with the use of the Colorado River basin. What are the advantages and disadvantages of China’s Three Gorges Dam?**6.** Describe the California Water Project and the controversyover this water transfer project. Describe the Aral Seadisaster. Describe China’s South–North Water TransferProject.**7.** Define **desalination** and distinguish between distillationand reverse osmosis as methods for desalinating water.What are the limitations of desalination and how mightthey be overcome?**8.** What percentage of the world’s water is unnecessarilywasted and what are two causes of such waste? Describefour irrigation methods and describe ways to reduce waterwaste in irrigation in developed and developing countries.List ways to reduce water waste in industry and homes.List ways to use water more sustainably. Describe ways inwhich you can reduce your use and waste of water. |

**Chapter 13 (continued)**

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| **9.** What is a **floodplain** and why do people like to liveon floodplains? What are the benefits and drawbacks offloods? List three human activities that increase the riskof flooding. Describe the increased risk that many peoplein Bangladesh face. How can we reduce the risks offlooding? | **10.** Describe relationships between water conflicts inthe Middle East (**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 14 – Nonrenewable Mineral Resources**

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| **1.** Define **mineral resource** and list three types of suchresources. Define **ore** and distinguish between a **high grade ore** and a **low-grade ore.** What are **reserves?** Describe the life cycle of a metal resource. Describe themajor harmful environmental effects of extracting, processing,and using nonrenewable mineral resources.**2.** Distinguish between **surface mining** and **subsurface****mining.** Define **overburden, spoils,** and **open-pit****mining.** Define **strip mining** and distinguish among**area strip mining, contour strip mining,** and **mountaintop****removal.** Describe the harmful environmental effects of mining. What is **smelting** and what are its major harmful environmental effects? What five nations supply most of the world’s nonrenewable mineral resources? How dependent is the United States on other countries for important nonrenewable mineral resources?**3.** Describe the advantages and disadvantages of the nanotechnology revolution. What are five possible optionswhen a mineral becomes economically depleted? Define**depletion time** and describe three types of depletioncurves for a mineral resource. Describe the conventionalview of the relationship between the supply of a mineralresource and its market price. What factors can influencethis market interaction? Describe the benefits and possibledrawbacks of nanotechnology. Discuss the pros and consof the U.S. General Mining Law of 1872. | **4.** Describe the opportunities and limitations of increasingmineral supplies by mining lower-grade ores. What arethe advantages and disadvantages of biomining?**5.** Describe the opportunities and limitations of getting more minerals from the ocean.**6.** Describe the opportunities and limitations of finding substitutes for scarce mineral resources and recycling andreusing valuable metals. Describe ways of using nonrenewable mineral resources more sustainably. Describe the Pollution Prevention Pays program of the Minnesota Mining and Manufacturing Company. What is an industrial ecosystem? Describe the industrial ecosystem operating in Kalundborg, Denmark.**7.** Describe the relationships between gold mining(**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 15 – Nonrenewable Energy**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 371. Summarize the issue of whether or not and when we are likely to run out of affordable oil.**2.** What major energy resources do the world and the United States rely on? Give a brief history of human energy use. What is **net energy** and why is it important in evaluating energy resources? Why does the nuclear power fuel cycle have a low net energy yield? | **3.** What is **crude oil** and how is it extracted from the earth and refined? What is a **petrochemical** and why are such chemicals important? Who controls most of the world’s oil supply? What percentage of the world’s proven oil reserves does the US have? How much of the world’s annual oil production does the US use and what percent of the oil it uses is imported? Describe the relationship between importing oil and fighting terrorism. Explain why the United States cannot even come close to meeting its oil needs by increasing domestic oil supplies. Discuss the pros and cons of drilling for oil in Alaska’s Arctic Wildlife Refuge. What are the major advantages and disadvantages of using conventional oil as an energy resource? |

**Chapter 15 (continued)**

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| **4.** What is **oil sand,** or **tar sand,** and how is it extractedand converted to heavy oil? What is **shale oil** and how isit produced? What are the major advantages and disadvantages of using heavy oils produced from oil sand and oil shales as energy resources?**5.** Define **natural gas, liquefied petroleum gas (LPG),**and **liquefied natural gas (LNG)?** What are the majoradvantages and disadvantages of using natural gas as anenergy resource? What are some problems involved withincreasing our use of LNG?**6.** What is **coal** and how is it formed? Compare the use ofcoal in the United States and China. What are the majoradvantages and disadvantages of using coal as an energyresource?**7.** What is **synthetic natural gas (SNG)?** What is coalliquefaction and how can liquid fuels be producedfrom coal? What are the major advantages and disadvantages of using liquid and gaseous synfuels produced from coal? | **8.** How does a nuclear fission reactor work and what are itsmajor safety features? Describe the *nuclear fuel cycle.* What factors have hindered the development of nuclear power? Describe the nuclear power plant accidents at Three Mile Island and Chernobyl. What are the major advantages and disadvantages of relying on nuclear power as a way to produce electricity?**9.** How can we deal with the highly radioactive wastes produced by nuclear power plants? Describe the controversy over this issue in the United States. What are our options for safely retiring worn out nuclear power plants? Discuss the degree to which nuclear power can reduce dependence on imported oil. Discuss the question of whether using nuclear power can help to significantly slow projected global warming. Discuss the pros and cons of building safer nuclear reactors. List the problems encountered in using breeder reactors. What is **nuclear fusion** and what is its potential as an energy resource? Summarize the arguments for and against relying more on nuclear power.**10.** Discuss the relationship between relying on oilas our major source of energy (**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 16 – Energy Efficiency and Renewable Energy**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 400. Describe Iceland’s attempt to develop a renewable energy economy by 2050.**2.** Distinguish between **energy conservation** and **energy****efficiency.** Explain why energy efficiency can bethought of as an energy resource. How much of the energyused in the United States is wasted unnecessarily?What are the major advantages of reducing energy waste?List three reasons why this source of energy has beenneglected?**3.** What is net energy efficiency and why is it important?Describe three ways to save energy and money in**(a)** industry, **(b)** transportation, and **(c)** buildings. What is**cogeneration (combined heat and power or CHP)?**Describe how Dow Chemicals has saved energy andmoney. Describe the trends in fuel efficiency in the UnitedStates since the 1970s. Explain why the price of gasolineis much higher than what consumers pay at the pump.What is a feebate? Distinguish among hybrid, plug-in hybrid, and fuel-cell motor vehicles. Describe five ways tosave energy in an existing building. | **4.** List five advantages of relying more on a variety of renewable sources of energy and describe two factors holding back such a transition.**5.** Distinguish between **passive solar heating** and **active****solar heating** and discuss the major advantages anddisadvantages of such systems. What are three ways tocool houses naturally? Discuss the major advantages anddisadvantages of using solar energy to generate high temperature heat and electricity. What is a **solar cell****(photovoltaic** or **PV cell)** and what are the major advantages and disadvantages of using such cells to produce electricity?**6.** What are the major advantages and disadvantages of using flowing water to produce electricity in hydropowerplants? What is the potential for using tides and waves, toproduce electricity? |

**Chapter 16 (continued)**

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| **7.** What is a wind turbine? What is a wind farm? What arethe major advantages and disadvantages of using windto produce electricity? What are the major advantagesand disadvantages of using wood to provide heat andelectricity? What are **biofuels** and what are the majoradvantages and disadvantages of using **(a)** biodiesel and**(b)** ethanol to power motor vehicles? Evaluate the useof corn, sugar cane, and cellulose plants to produceethanol.**8.** What is **geothermal energy** and what are three sourcesof such energy? What are the major advantages and disadvantages of using geothermal energy as a source of heat and to produce electricity? What are the major advantages and disadvantages of burning hydrogen gas to provide heat, to produce electricity, and to fuel cars? | **9.** List three general conclusions of energy experts aboutpossible future energy paths for the world. List five majorstrategies for making the transition to a more sustainableenergy future. Describe three roles that governments playin determining which energy resources we use. Describewhat the U.S. state of California has done to improve energy efficiency and rely more on various forms of renewable energy.**10.** Describe how Iceland’s pursuit of a renewable energyeconomy (**Core Case Logo**) applies the four **scientific principles of sustainability.** |

**APES REVIEW – Pollution and Global Change**

**Key Questions & Learning Targets**

**Chapter 17 – Environmental Hazards and Human Health**

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| **1.** Review the Key Questions and Concepts for thischapter on p. 439. Describe how an HIV/AIDs epidemic(**Core Case Study**) in a country can affect the agestructure of its population.**2.** Distinguish among **risk, risk assessment,** and **risk****management.** Distinguish between possibility and probability. What is a **pathogen?** Give an example of a riskfrom each of the following: biological hazards, chemicalhazards, physical hazards, cultural hazards, and lifestylechoices.**3.** Distinguish among a **nontransmissible disease, infectious disease,** and **transmissible disease** and give anexample of each. In terms of death rates, what are theworld’s four most serious infectious diseases? Distinguishbetween an epidemic and a pandemic of an infectiousdisease. Describe the causes and possible solutions for theincreasing genetic resistance in microbes to commonlyused antibiotics.**4.** Describe the global threat from tuberculosis. Describe the threat from flu and the effects of a global flu pandemic. Describe the health threats from the global HIV/AIDS pandemic and list six ways to reduce this threat. Describe the threats from the hepatitis B, West Nile, and SARS viruses. Describe the threat from malaria for 40% of the world’s people and how we can reduce this threat.**5.** Give three examples of problems being studied in the new field of ecological medicine. What is Lyme disease, and how can individuals reduce their chances of getting it?List five major ways to reduce the global threat from infectious diseases. | **6.** What is a **toxic chemical?** Discuss the threat from PCBs.Distinguish among **mutagens, teratogens,** and **carcinogens,** and give an example of each. Describe the toxiclegacy from PCBs. Describe the human immune, nervous,and endocrine systems and give an example of a chemicalthat can threaten each of these systems. Describe thetoxic effects of the various forms of mercury and ways toreduce these threats. What are hormonally active agents,what risks do they pose, and how can we reduce theserisks? Describe the potential threats from bisphenol A.**7.** Define **toxicology, toxicity, dose,** and **response.** Givethree reasons why children are more vulnerable to harmfrom toxic chemicals. Describe how the toxicity of a substance can be estimated by using laboratory animals, and discuss the limitations of this approach. What is a **dose response** **curve?** Describe how toxicities are estimated by case reports and epidemiological studies and discuss the limitations of these approaches. Why do we know so little about the harmful effects of chemicals? Discuss the use of pollution prevention and the precautionary principle in dealing with health threats from chemicals.**8.** What is **risk analysis?** In terms of premature deaths,what are the three greatest threats that humans face? Describe the health threats from smoking and what can bedone to reduce these threats.**9.** How can we reduce the threats from the use of varioustechnologies? What five factors can cause people to misjudge risks? List five principles that can help us evaluate and reduce risk.**10.** Discuss how lessening the threats of HIV/AIDSand other major infectious diseases (**Core Case Study**) can be achieved by applyingthe four **scientific principles of sustainability**. |

**Chapter 18 – Air Pollution**

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| **1.** Review the Key Questions and Concepts for this chapter on p. 469. Describe the nature and harmful effects ofthe massive Asian Brown Cloud (**Core Case Study**).**2.** Define **density, atmospheric pressure, troposphere,****stratosphere,** and **ozone layer.** Describe how the troposphere and stratosphere differ.**3.** What is **air pollution?** Summarize the history of air pollution. Distinguish between **primary pollutants** and**secondary pollutants** and give an example of each. Listthe major outdoor air pollutants and their harmful effects.**4.** Describe the effects of lead as a pollutant and how we can reduce our exposure to this chemical. Describe a chemical method and a biological method for detecting airpollutants.**5.** Distinguish between **industrial smog** and **photochemical smog** in terms of their chemical composition andformation. List and briefly describe five natural factorsthat help to reduce outdoor air pollution and six naturalfactors that help to worsen it. What is a **temperature inversion** and how can it affect air pollution levels?**6.** What is **acid deposition** and how does it form? Brieflydescribe its major environmental impacts on vegetation,lakes, human-build structures, and human health. Listthree major ways to reduce acid deposition. | **7.** What are the top four indoor air pollutants in the UnitedStates? What is the major indoor air pollutant in manydeveloping countries? Describe indoor air pollution byradon-222 and what can be done about it.**8.** Briefly describe the human body’s defenses against airpollution, how they can be overwhelmed, and illnessesthat can result. About how many people die prematurelyfrom air pollution each year?**9.** Describe air pollution laws in the United States. Summarize the accomplishments of such laws and discuss how they can be improved. List the advantages and disadvantages of using an emissions trading program. Summarize the major ways to reduce emissions from power plants and motor vehicles. What are four ways to reduce indoor air pollution?**10.** Discuss the relationship between the Asian BrownCloud (**Core Case Study**) and the ways in which people have violated the four **scientific** **principles of sustainability**. |

**Chapter 19 – Climate Change and Ozone Depletion**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 497. Describe how a major volcanic eruption(**Core Case Study**, Figure 19-1) allowed scientists totest the validity of climate models.**2.** Describe global warming and cooling over the past900,000 years and during the last century. How do scientists get information about past temperatures andclimates? What is the greenhouse effect and why is it soimportant to life on the earth? What is the scientific consensus about global temperature change during the last half of the 20th century and about projected temperature changes during this century? | **3.** How can positive feedback loops affect future temperature changes and thus global climate? Give two examples of such loops. Describe the role played by oceans in the regulation of atmospheric temperatures. What are three factors that could decrease its effect in moderating temperature increases?**4.** Describe how each of the following might affect globalwarming and its resulting effects on global climate:**(a)** cloud cover and **(b)** air pollution. Briefly describethe projections of scientists on how global warmingis likely to affect: drought; ice cover; flooding; sealevels; permafrost; ocean currents; extreme weather;biodiversity; crop yields; and human health during thiscentury. |

**Chapter 19 (continued)**

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| **5.** What are five reasons for the fact that it is difficult to deal with the problem of climate change due to global warming caused mostly by human activities? What are four major strategies for slowing projected climate change? What is **carbon capture and storage (CCS)?** Describe six problems associated with capturing and storing carbon dioxide emissions.**6.** List four things that governments could do to help slowprojected climate change. What are the pros and cons ofthe Kyoto Protocol? What have the U.S. state of Californiaand the U.S. city of Portland, Oregon, done to help reducetheir greenhouse gas emissions?**7.** Give two examples of what some major corporationsand some schools have done to reduce their carbonfootprints. List five ways in which you can reduce yourcarbon footprint. List five ways in which we can preparefor the possible long-term harmful effects of climatechange. | **8.** Describe how human activities have depleted ozone in the stratosphere, and list five harmful effects of such depletion. Describe how scientists Sherwood Roland and Mario Molina helped to awaken the world to this threat. Describe the relationships between higher UV levels and three types of skin cancer. What has the world done to help reduce the threat from ozone depletion in the stratosphere?**9.** Describe how the four **scientific principles of sustainability** can be applied to deal withthe problems of climate change (**Core Case Study**) and ozone depletion. |

**Chapter 20 – Water Pollution**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 532. Describe the cleanup of Lake Washington nearSeattle (**Core Case Study**) and list the three lessonslearned from this process.**2.** What is **water pollution?** Distinguish between **point****sources** and **nonpoint sources** of water pollution andgive an example of each. List nine major types of waterpollutants and give an example of each. List three diseasestransmitted to humans by polluted water. Describe chemical and biological methods that scientists use to measure water quality.**3.** Describe how streams can cleanse themselves and howthese cleansing processes can be overwhelmed. Describethe state of stream pollution in developed and developingcountries. Describe the pollution problems of the GangesRiver, which runs through part of India.**4.** Give two reasons why lakes cannot cleanse themselves as readily as streams can. Distinguish between **eutrophication** and **cultural eutrophication.** List three ways to prevent or reduce cultural eutrophication. Describe pollution of the Great Lakes and the progress made in reducing this pollution. | **5.** Explain why groundwater cannot cleanse itself very well.What are the major sources of groundwater contamination in the United States? Describe the threat from arsenic in groundwater. List ways to prevent or clean up groundwater contamination.**6.** Describe U.S. laws for protecting drinking water quality.Describe the environmental problems caused by the widespread use of bottled water.**7.** How are coastal waters and deeper ocean waters polluted? What causes harmful algal blooms and what aretheir harmful effects? Describe oxygen depletion in thenorthern Gulf of Mexico. How serious is oil pollution ofthe oceans, what are its effects, and what can be done toreduce such pollution?**8.** List two ways to reduce water pollution from **(a)** nonpoint sources and **(b)** point sources. Describe the U.S.experience with reducing point-source water pollution.What is a **septic tank** and how does it work? Describehow **primary sewage treatment** and **secondary****sewage treatment** are used to help purify water. |

**Chapter 20 (continued)**

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| **9.** How would Peter Montague improve conventional sewage treatment? What is a composting toilet system? Describe how wetlands can be used to treat sewage. Describe the use of living machines to treat sewage. List six ways to prevent and reduce water pollution. List five steps you can take to reduce water pollution. | **10.** Describe connections between the clean upof Lake Washington (**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 21 – Solid and Hazardous Waste**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 561. Describe the problems associated with electronic waste (e-waste) (**Core Case Study**).**2.** Distinguish among **solid waste, industrial solid****waste, municipal solid waste (MSW),** and **hazardous****(toxic) waste** and give an example of each. Givetwo reasons for sharply reducing the amount of solid andhazardous waste we produce. Describe the production ofsolid waste in the US and what happens to such waste.**3.** Distinguish among **waste management, waste reduction,** and **integrated waste management.** Describe thepriorities that prominent scientists believe we should usefor dealing with solid waste. What is garbology? Distinguishamong **reducing, reusing,** and **recycling** as strategiesfor waste reduction. Describe six ways in which industriesand communities can reduce resource use, waste,and pollution.**4.** Explain why reusing and recycling materials are so important and give two examples of each. Describe the importance of using refillable containers and list five other ways to reuse various items. Distinguish between **primary****(closed-loop)** and **secondary recycling** and give anexample of each. Describe two approaches to recyclinghousehold solid wastes and evaluate each approach. Whatis a materials recovery facility? What is composting?**5.** Describe the recycling of paper and the problems involved. Describe the recycling of plastics and the problems involved. Describe progress in recycling plastics.What are bioplastics? What are the major advantages and disadvantages of recycling? What are three factors thatdiscourage recycling? Describe three ways to encouragerecycling and reuse. | **6.** What are the major advantages and disadvantages of using incinerators to burn solid and hazardous waste? Distinguish between **open dumps** and **sanitary landfills.**What are the major advantages and disadvantages ofburying solid waste in sanitary landfills?**7.** What are the priorities that scientists from the NationalAcademy of Sciences believe we should use in dealingwith hazardous waste? What is phytoremediation andwhat are the major advantages and disadvantages of usingit to remove or detoxify hazardous wastes? What arethe major advantages and disadvantages of using a plasmatorch to detoxify hazardous wastes?**8.** What are the major advantages and disadvantages ofdisposing of liquid hazardous wastes in **(a)** deep underground wells and **(b)** surface impoundments? What is a secure hazardous waste landfill? Describe the regulation of hazardous waste in the United States underthe Resource Conservation and Recovery Act and theComprehensive Environmental Response, Compensation,and Liability (or Superfund) Act. What is a brownfield?**9.** How has grassroots action improved solid and hazardous waste management in the United States? What is **environmental** **justice** and how well has it been appliedin locating and cleaning up hazardous waste sites in theUnited States? Describe regulation of hazardous wastesat the global level through the Basel Convention and thetreaty to control persistent organic pollutants.**10.** Describe connections between dealing withthe growing problem if e-waste (**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 22 – Sustainable Cities**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 589. Describe how Curitiba, Brazil, has attempted tobecome a more sustainable city (**Core Case Study**).**2.** Distinguish between **urbanization** and **urban****growth.** Describe two factors that increase the populationof a city.**3.** List four trends in global urban growth. Describe fourphases of urban growth in the United States.**4.** What is **urban sprawl?** List six factors that have promoted urban sprawl in the United States. List five undesirable effects of urban sprawl.**5.** What are four advantages of urbanization? What are sixdisadvantages of urbanization? What is **noise pollution**and how can it be reduced? Explain why most cities andurban areas are not sustainable.**6.** What are squatter settlements and shantytowns? Describe some of the problems faced by the poor who live in urban areas. How can governments help to reduce theseproblems? Describe the urban problems of Mexico City,Mexico. | **7.** Distinguish between compact and dispersed cities and give an example of each. What are the major advantages and disadvantages of motor vehicles? List four ways to reduce dependence on motor vehicles. Describe the major advantages and disadvantages of relying more on **(a)** bicycles, **(b)** mass transit rail systems, and **(c)** bus rapid transit systems within urban areas, and **(d)** rapid-rail systems between urban areas. Describe the destruction of the early mass transit system in the United States.**8.** What is **land-use planning?** What is **zoning** and whatare its limitations? What is **smart growth?** List five toolsused to promote smart growth. Describe strategies usedby the U.S. city of Portland, Oregon, to help control urbansprawl and reduce dependence on automobiles.**9.** What are the five guiding principles of new urbanization? What is cluster development? List ten goals of ecocity and ecovillage design. Describe Shanghai, China’s plan to build an ecocity called Dongtan. Describe three strategies used within ecovillages to make their neighborhoods more sustainable.**10.** Explain how people in Curitiba, Brazil (**Core Case Study**) have applied each of the four **scientific principles of sustainability** to make their city more sustainable. |

**Chapter 23 – Economics, Environment, and Sustainability**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 612. Describe the disagreements among someeconomists over economic growth versus economic development (**Core Case Study**). Explain why thesustainability revolution is also an economicrevolution.**2.** What is an **economic system?** Distinguish among **natural capital, human capital (human resources),** and**manufactured capital (manufactured resources).** Describethe interactions among demand, supply, and marketprices in a market economic system. Explain why andhow governments intervene in market economic systems.What is a **high-throughput economy?****3.** Compare how neoclassical economists and ecological and environmental economists view economic systems. List eight strategies that ecological and economic economists would use to make the transition to more sustainable eco-economies. | **4.** Describe ways in which economists can estimate the economic values of natural goods and services. Why are such values not included in the market prices of goods and services? Define **discount rate** and discuss the controversyover how to assign such rates.**5.** Describe how economists can estimate the optimallevels for pollution control and resource use. Define**cost-benefit analysis** and discuss its advantages andlimitations.**6.** Why do products and services cost more than most people think? What is the *genuine progress indicator* and how does it differ from the gross domestic product economic indicator? What is *full-cost pricing* and what are some benefits of using it to determine the market values of goods and services? Give three reasons why it is not widely used. What are the advantages of providing consumers with eco-labels on the goods and services they buy? |

**Chapter 23 (continued)**

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| **7.** Describe the benefits of shifting from environmentallyunsustainable to more environmentally sustainable government subsidies and tax breaks. Describe the proposal to tax pollution and wastes instead of wages and profits. What are the major advantages and disadvantages of using green taxes? What are three requirements for implementing green taxes? Distinguish between commandand- control and incentive-based government regulations, and describe the advantages of the second approach. What is the cap-and-trade approach to implementing environmental regulation, and what are the major advantages and disadvantages of this approach?**8.** What are some environmental benefits of selling services instead of goods? Give two examples of this approach. Describe Ray Anderson’s progress in developing a more environmentally sustainable carpet business. | **9.** What is **poverty** and how is it related to populationgrowth and environmental degradation? List three waysin which governments can help to reduce poverty. Whatare the advantages of making microloans to the poor?**10.** What is a **matter recycling and reuse economy?** Whatis a **low-throughput (low-waste) economy?** List sixways to shift to more environmentally sustainable economies. Name five new businesses and careers that would be important in such eco-economies. Describe connections between more environmentally sustainableeconomies (**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 24 – Politics, Environment, and Sustainability**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 635. Describe what Marion Stoddart did tohelp clean up the Nashua River in the U.S. state ofMassachusetts (**Core Case Study**).**2.** What key roles can governments play in improvingenvironmental quality? What is a government **policy?** What is **politics?** What is **environmental** **policy?** What are the four stages of a policy life cycle in democracies? What is a **democracy?** Describe two features of democratic governments that hinder their ability to deal with environmental problems. Explain nine principles that decision makers can use in making environmental policy and five strategies for implementing these principles.**3.** What are the three branches of government in theUnited States and what major role does each play? What is **lobbying?** What are three major environmental laws? Explain why developing environmental policy is a difficult and controversial process. What are four major types of public lands in the United States? Describe the controversy over managing these lands. Describe the controversy over logging in U.S. National Forests.**4.** Describe four ways in which individuals in democraciescan help to develop or change environmental policy.What does it mean to say that we should *think globally**and act locally?* Give an example of such an action. Whatare four ways to provide environmental leadership? | **5.** What is **environmental law?** Distinguish among a**statutory law,** an **administrative law,** and a **common law.** What is a **civil suit?** What are the **plaintiff** andthe **defendant** in a lawsuit? List six reasons why it is difficult to win an environmental lawsuit. What is a SLAPP?Describe the role that Diane Wilson played in helping toreduce the dumping of toxic chemicals into the bay nearwhere she lived. Distinguish between **arbitration** and **mediation** in dealing with a lawsuit. List three generaltypes of U.S. environmental laws. What is an environmental impact statement?**6.** Explain how and why U.S. environmental laws have been under attack since 1980. How effective have the attacks been? Describe Julia “Butterfly” Hill’s efforts to save giant redwood trees in California.**7.** Describe the roles of grassroots and mainstream environmental organizations and give an example of each type of organization. Describe the role and effectiveness of the Natural Resources Defense Council (NRDC). Give twoexamples of how students have played strong roles in improving environmental quality.**8.** Explain the importance of environmental security, relative to economic and military security. Describe some harmful environmental impacts of war. List two pieces of good news and bad news about international efforts to deal with environmental problems. List three problems with global environmental treaties and agreements. Describe roles that corporations can play in helping to achieve environmental sustainability, and give an example. |

**Chapter 24 (continued)**

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| **9.** Describe efforts by the Netherlands to develop and implement a national environmental plan, or green plan. What are four guidelines for shifting to more environmentally sustainable societies? | **10.** Describe connections between Marion Stoddart’sefforts to restore and protect a river (**Core Case Study**) and the four **scientific principles of sustainability**. |

**Chapter 25 – Environmental Worldviews, Ethics, and Sustainability**

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| **1.** Review the Key Questions and Concepts for this chapteron p. 661. Describe the Biosphere 2 project (**Core Case Study**) and the major lessons learned fromthis project.**2.** What is an **environmental worldview?** What are **environmental ethics?** Distinguish among the followingenvironmental worldviews: **planetary management,****stewardship, environmental wisdom,** and **deep****ecology****3.** List three issues involved in deciding which species to protect from premature extinction as a result of our activities. Discuss the controversy over whether we can effectively manage the earth.**4.** List eight goals for a person seeking environmental literacy. List four questions that lie at the heart of environmental literacy.**5.** Describe three ways in which we can learn from theearth. What does it mean to find a *sense of place?* | **6.** What is sustainability, if not all about sustaining resources for human use? List six guidelines for achieving more sustainable and compassionate societies.**7.** Describe the relationship between owning things and being happy. What is *voluntary simplicity?* What are threeexamples of basic needs? What are five examples of morequalitative needs? List a dozen steps that are among theimportant steps that can be taken to make the transitionto more sustainable societies.**8.** Describe three traps that lead to denial, indifference,and inaction concerning the environmental problemswe face. What are the four basic principles of the EarthCharter?**9.** What role might religion play in making the transition tomore sustainable societies? List seven components of theenvironmental or sustainability revolution.**10.** Describe connections between Biosphere 2 (**Core Case Study**), the transition to more environmentally sustainable societies, and the four **scientific principles of sustainability**. |